

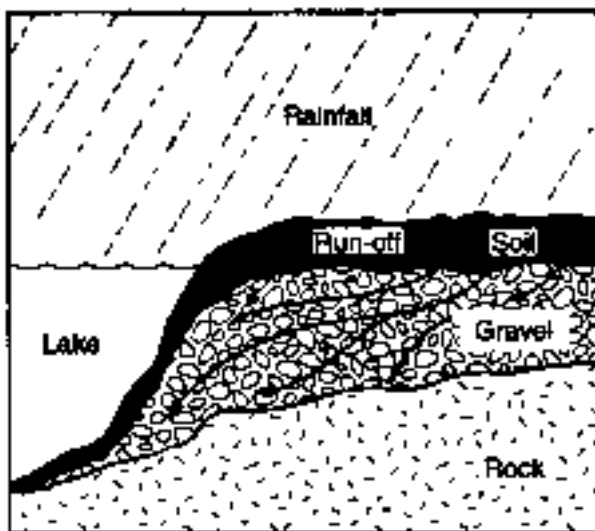
Soiled Again

You will be investigating a problem related to acid rain. During this activity, you will work with a partner (or possibly two partners). However, you must keep your own individual lab notes because after you finish you will work independently to write a report about your investigation.

The Problem

Acid rain refers to rain, snow or other precipitation with a pH below 5.6. In extreme cases, acid rain can have a pH as low as 2.0! Many lakes in the Northeastern United States appear to be suffering harmful effects from acid rain. Although they often look crystal clear, these lakes have significant decreases in their number of fish and other life forms.

Yet other lakes in the same region seem healthy. The reason may have to do with the rocks and soil that surround the lakes. Some rain falls directly into rivers and lakes, but much of it hits the ground first and then flows or seeps into the bodies of water (see the diagram below). When acid rain flows through soil and gravel that have a higher pH than the rain, the pH of the rain may change. The rate at which the rain percolates or seeps through the soil and gravel is another important factor that affects the neutralization of the acid. If it seeps through too quickly, there may not be time for a noticeable change in pH to occur.



Your Task

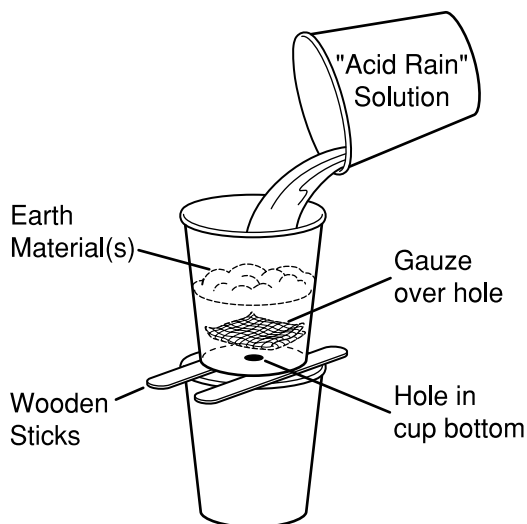
You and your partner will design and conduct experiments to determine which earth material (sand, potting soil or limestone) or combination of earth materials will best reduce the acidity of "acid rain." You will use a vinegar-and -water solution as a substitute for acid rain. You will investigate the problem by studying the percolation rate (the rate at which water seeps through a material) and neutralizing ability (ability of materials to reduce the acidity of acids) of various earth materials.

You have been provided with the following materials and equipment:

Sand (1/2 cupful)	Ruler
Potting soil (1/2 cupful)	Plastic spoon
Crushed limestone (1/2 cupful)	Paper cups (8)
Vinegar (200 mL)	Square bandages (4)
Tap water	Wooden sticks
pH test strips (10) and pH color chart	Graduated cylinder
Access to balance	Large beaker
Access to a clock or a watch with a second hand	
Access to a calculator	
Paper towels for cleanup	
Safety equipment (including goggles and aprons)	

Steps to follow

1. In your own words, state the problem you are going to investigate, and write your statement of the problem on the page provided.
2. Design one or more experiments to solve the problem. Describe your experimental designs on the page provided. Show your designs to your teacher before you begin your experiments. (Hint: There are several ways to investigate this problem. The illustration below may give you one idea for designing your experiments.)



3. Mix the 200 mL of vinegar with 1 00 mL of water in the large beaker to create an "acid rain" solution. Use the plastic spoon to stir the vinegar and water, and then use a pH test strip to determine the acidity of the solution.

4. After receiving approval from your teacher, work with your partner to carry out your experiments. Your teachers approval does not necessarily mean that your teacher thinks your experiments are well designed. It simply means that in your teacher's judgment your experiments are not dangerous or likely to cause an unnecessary mess.

5. While conducting your experiments, take notes on the pages provided. Space is also provided for charts, tables or graphs. Your notes will **not** be scored, but they will be helpful to you later as you work independently to write about your experiments and the results. You **must** keep your own notes because you will not work with your partner when your write your report. Later, you will work independently to write about your investigation in the form of a report to a planning commission that is trying to decide which earth material should be used around a local lake in order to reduce the effects of acid rain. Take a few minutes to find out what you should include in your report.

When you have finished your experiments, your teacher will give you instructions for clean-up procedures, including proper disposal of all materials.

(Students are provided with 4 blank pages for their notes)

Directions for Writing Your Report

You will now summarize your experiments and results in the form of a report to a planning commission that is trying to decide which earth material should be used around a local lake in order to reduce the effects of acid rain. You may use the lab notes you took while working with your partner. You may wish to write a first draft of your report on scratch paper, but your final copy should be written on the pages provided. Space for charts, tables or graphs is provided.

Your report should include:

- a clear statement of the problem you investigated;
- a description of the experiments you carried out;
- the results of your experiments (including data presented in the form of charts, tables or graphs);
- your conclusions from the experiments; and
- comments about how valid you think your conclusions are. (in other words, how much confidence do you have that your results are accurate? What errors may have affected your results?)

(Students are provided with 4 blank pages for their report)

Soiled Again Experimentation Questions

A group of students prepared a vinegar-and-water solution to simulate acid rain. After determining its pH, they poured the solution through cups that contained various earth materials (sand, potting soil and crushed limestone). The students measured the amount of solution that percolated (passed) through a hole in the bottom of each cup in a set amount of time, and they tested the pH of the drippings.

The results of the group's experiment are shown in the following table.

Earth materials	pH of "acid rain" before percolation	Amount of "acid rain" percolated in 3 minutes	pH of percolated "acid rain"
Sand	3.0	30 ml	3.5
potting soil	3.0	20 ml	3.5
crushed limestone	3.0	90 ml	5.0
all Earth materials	3.0	50 ml	5.5

1. What is one problem that this group is investigating? State the problem in your own words.
2. What are the variables that need to be controlled in this experiment? Explain why it is important to control them.
3. Do you have enough information to replicate this group's experiment? If you think you do, tell what information you have. If you think you do not, tell what other information you would need.
4. The group concluded that sand and potting soil have the same ability to neutralize acidity because in each case the pH went from 3.0 to 3.5. Based on this group's experiment and results, do you think the group's conclusion is valid? Explain why or why not.